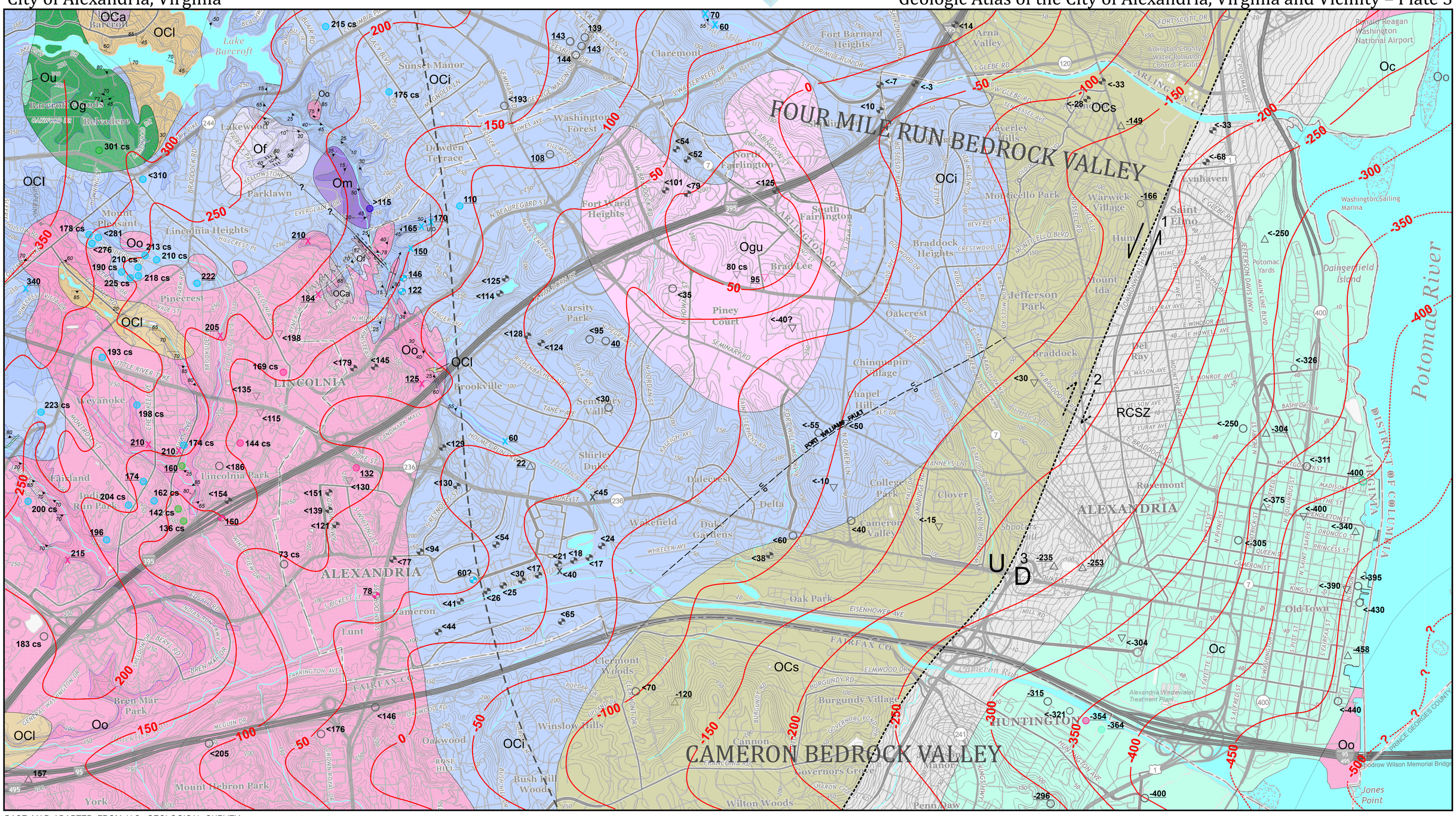


BASE MAP ADAPTED FROM U.S. GEOLOGICAL SURVEY NATIONAL MAP, 2013: TOPOGRAPHIC MAPS OF THE ALEXANDRIA, VA-DC-MD AND ANNANDALE, VA 7.5-MINUTE QUADRANGLES, NAD 1983

MAP LOCATION

SCALE 1:12,000

1 .5 0 KILOMETERS 1 2

1000 0 METERS 1000 2000

1 .5 0 1

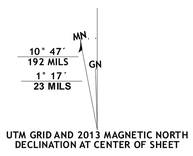
MILES

1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

FEET

CONTOUR INTERVAL 10 FEET

NORTH AMERICAN VERTICAL DATUM OF 1988



UTM GRID AND 2013 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

DESCRIPTION OF THE MAP

Plate 3 depicts the geology of the early Paleozoic crystalline bedrock, which is present in the subsurface everywhere beneath the map area. The bedrock is part of the mid-Atlantic Piedmont, which occupies the area between the Blue Ridge Mountains and the Atlantic Coastal Plain. The rocks in the map area formed about 450 to 550 million years ago in a volcanic arc associated with the Taconic subduction zone. The oldest rocks were probably deposited in or near a submarine trench before being metamorphosed, folded, and intruded by several phases of plutonic rocks. Major strike-slip faulting deformed the rocks throughout the Paleozoic.

Piedmont bedrock crops out only in the extreme western part of the city and points west in nearby Fairfax County, mainly in the major stream valleys. Elsewhere the bedrock is concealed beneath much younger Coastal Plain deposits and river terraces, becoming increasingly deeply buried eastward across the city. Along the Potomac River at Old Town, more than 400 feet of these strata overlie the bedrock surface. A combination of regional geophysical data, knowledge of bedrock structure in adjacent quadrangles, and descriptions of bedrock encountered in scattered boreholes beneath the Coastal Plain allow inferences to be drawn about the distribution and structure of rock units where the bedrock is concealed.

The map also shows the topography of the buried bedrock surface which, at most places, coincides with the base of the early Cretaceous Potomac Formation. The configuration of this major erosional unconformity was reconstructed from a variety of outcrop and borehole data, some of which provide firm altitudes of the bedrock surface, while others give a minimum depth to bedrock.

For this atlas, only the bedrock beneath the City of Alexandria, far southern Arlington County, and Holmes Run Gorge between the city and Lake Barcroft was mapped in detail. The bedrock geology of adjacent parts of Fairfax County was adapted from Drake and Froelich (1986) and Huffman (1975) with only minor modifications. A more detailed description of the bedrock geology, this map, and how it was compiled can be found in "Plate 3: Bedrock geology and topography - expanded explanation".

REFERENCES AND DATA SOURCES

Daniels, D.L., 1980, Geophysical-geological analysis of Fairfax County, VA: U.S. Geological Survey Open-File Report 80-1165, 64 p.

Darton, N.H., 1950, Configuration of the bedrock surface of the District of Columbia and vicinity: U.S. Geological Survey Professional Paper 217, 42 p.

Drake, A.A., Jr, 1985, Tectonic implications of the Indian Run Formation—a newly recognized sedimentary mélange in the northern Virginia Piedmont: US Geological Survey Professional Paper 1324, 12 pp.

Drake, A.A., Jr., and Froelich, A.J., 1986, Geologic Map of the Annandale Quadrangle, Fairfax County, Virginia: U.S. Geological Survey Geologic Quadrangle Map GQ-1601, scale 1:24,000.

Drake, A.A., Jr., and Lyttle, P.T., 1981, The Accontink Schist, Lake Barcroft Metasandstone, and Popes Head Formation—keys to an understanding of the tectonic evolution of the northern Virginia Piedmont: U.S. Geological Survey Professional Paper 1205, 16 pp.

Fleming, A.H., and Drake, A.A., Jr., 1998, Structure, age, and tectonic setting of a multiply-reactivated shear zone in the Piedmont in Washington, D.C., and vicinity: Southeastern Geology, v. 37 (3), p. 115-140.

Fleming, A.H., Drake, A.A., Jr., and McCartan, L., 1994, Geologic Map of the Washington West Quadrangle, DC-MD-VA: U.S. Geological Survey Geologic Quadrangle Map GQ-1748, Scale 1:24,000.

Froelich, A.J., 1985, Folio of geologic and hydrologic maps for land-use planning in the Coastal Plain of Fairfax County, Virginia, and vicinity: U.S. Geological Survey Miscellaneous Investigations Series Map (IMAP) I-1423, scale 1:100,000.

Hopson, C.A., 1964, The crystalline rocks of Howard and Montgomery Counties, *in* The Geology of Howard and Montgomery Counties, Maryland: Baltimore, Maryland Geological Survey. p 27 - 215.

Huffman, A.C., 1975, The geology of the crystalline rocks of northern Virginia in the vicinity of Washington, D.C: Washington, D.C., George Washington University, unpublished Ph.D. dissertation, 129 pp.

Johnston, P.M., 1961, Geology and ground-water resources of Washington, D.C. and vicinity - well records and data tables: U.S. Geological Survey Open-File Report 61-79.

Johnston, P.M., 1964, Geology and ground-water resources of Washington, D.C. and vicinity: U.S. Geological Survey Water Supply Paper 1776. 98 p.

Southwick, D.L., Reed, J.C., Jr., and Mixon, R.B., 1971, The Chopawamsic Formation – A new stratigraphic unit in the Piedmont of northeastern Virginia: U.S. Geological Survey Bulletin 1324-D, p. D1 - D11.

MAP EXPLANATION

Description of Rock Units (darker tones: areas of bedrock outcrop; lighter tones: bedrock concealed beneath younger sediments)

RCSZ — **Rock Creek Shear Zone (early Ordovician through Cenozoic; Fleming and Drake, 1998)**. Dense, fine-grained phyllonite, welded mylonite, and ultramylonite derived from adjacent rock units during multiple episodes of ductile fault motion along the Rock Creek Fault. Not exposed in map area. Position on the map is defined by an intense aeromagnetic lineament that extends southward out of the Washington West quadrangle, where the shear zone is well exposed and up to a mile wide in central Rock Creek Park. Several reverse faults of Cenozoic age are localized within the shear zone in that area. In Alexandria, the magnetically defined trace of the fault zone closely parallels the base of the massive Mt. Ida escarpment

Ogu — **Undifferentiated granitic rocks**. Forms a large body below northern Alexandria and southernmost Arlington. Known only from a pronounced, deep, aeromagnetic anomaly and a corresponding report of "granite" from a deep well near Episcopal Seminary. Appears to underlie a topographic high on the bedrock surface

Oo — **Occoquon Granite (early Ordovician; Drake and Froelich, 1986)**. Coarse-grained, well-foliated, light gray muscovite-biotite monzogranite. Along Holmes Run, the granite intrudes the Annandale Group and Indian Run Formation and is folded with the enclosing wallrocks

Oc — **Chopawamsic Formation (early Ordovician; Southwick and others, 1971)**. Metamorphosed mafic to felsic volcanic rocks and sediments. Not exposed in map area, but geophysical evidence indicates it is the main rock unit east of the Rock Creek Shear Zone and floors the Coastal Plain beneath Old Town, where "green rock" and "flint" are reported from deep wells

Of — **Falls Church Tonalite (early Ordovician; Drake and Froelich, 1986; 1997)**. Medium to coarse-grained, dark gray, massive to well foliated hornblende-biotite tonalite. Two bodies of this unit are exposed in Holmes Run Gorge

Og — **Quartz gabbro (early Ordovician?)**. Medium to coarse-grained, dark green, red-weathering, augite-hornblende-quartz gabbro, locally metamorphosed to a well-foliated, black amphibolite. Similar to gabbro of the Georgetown Intrusive Suite in the Washington West quadrangle. Forms a somewhat poorly exposed body centered on Barcroft Woods

Ou — **Soapstone and talc schist (early Ordovician?)**. Poorly exposed lenticular body of massive to schistose, medium green ultramafic rock composed of talc, chlorite, anthophyllite, and quartz. Lies along the western edge of and is probably related to the much larger gabbro body at Barcroft Woods

Om — **Muscovite monzogranite (early Ordovician? Drake and Froelich, 1986)**. Fine- to medium-grained, well-foliated, pinkish-white muscovite monzogranite. Crops out just west of the city limits in Holmes Run Gorge, where it intrudes the Indian Run Formation, and is itself intruded by small bodies of Occoquon Granite

OCs — **Sykesville Formation (Cambrian(?) and early Ordovician; Hopson, 1964)**. Very similar to the Indian Run Formation. Not exposed in the map area. Interpreted to extend beneath the Coastal Plain in the eastern part of the city from the adjacent Washington West quadrangle, where it is extensively exposed along the Potomac River

OCl — **Indian Run Formation (Cambrian(?) and early Ordovician; Drake, 1985; Drake and Froelich, 1986)**. Medium-grained metadiamictite containing scattered quartz lumps and dark biotite schist "wafers", along with sparse inclusions of Lake Barcroft Metasandstone, Accotink Schist, felsic metavolcanic rocks, and rare mafic and ultramafic rocks, set in a gray, massive to foliated, quartzofeldspathic matrix with variable amounts of mica and garnet. The origin of the Indian Run Formation is enigmatic, but it was probably deposited in a submarine trench in the Taconic subduction zone, and may be more than 10,000 feet thick in and near the map area. Most of the rock exposed in Holmes Run Gorge is clast poor and is intruded by small bodies of Occoquon Granite; downstream of Shirley Highway, however, it contains abundant inclusions

OCl / OCa — **Annandale Group (Cambrian and/or early Ordovician; Drake and Lyttle,1981; Drake and Froelich, 1986)**. OCl–Lake Barcroft Metasandstone: fine-grained, light gray, meta-arenite and quartz-rich metagraywacke. Within the city limits it forms a swarm of large xenoliths in Occoquon Granite upstream of Shirley Highway, and occurs as thin beds within Accotink Schist in Rynex Natural Area. Forms much larger bodies elsewhere in Fairfax County. OCa–Accotink Schist: medium- to coarse-grained, gray-brown, garnetiferous muscovite-biotite schist. Forms thin, highly folded screens or roof pendants in Occoquon Granite and Falls Church Tonalite between Holmes Run and the head of Rynex Natural Area

Structure Symbols

Contact. Dotted where concealed by water, highly approximate where rock units are buried beneath Coastal Plain strata

Faults. Dashed where concealed beneath Coastal Plain strata, dotted and queried where uncertain.

Strike-slip fault. Arrows indicate sense of displacement. Numbers on Rock Creek Fault denote successive episodes of early-Paleozoic sinistral motion (1), mid- to late Paleozoic dextral motion (2), and late Paleozoic through Cenozoic reverse motion (U/D 3), respectively

U/D — Reverse fault observed in outcrop. U/D indicates upthrown and downthrown sides, respectively

Reverse fault in overlying Coastal Plain strata and upland terrace units, inferred to cut bedrock

75 — Small fault seen in outcrop by Drake and Froelich (1986), showing dip, displacement unknown

Planar Structures

50 — Strike and dip of metamorphic foliation of indeterminate age

45 — Strike and dip of transposition foliation in stratified rocks

80 — Strike and dip of igneous flow foliation in Falls Church tonalite

65 — Strike and dip of first-generation bedding schistosity

35 — Strike and dip of second generation schistosity

85 — Strike and dip of mylonitic foliation in ductile fault zones

Shear zone observed in outcrop: mylonite and phyllonite; *Q* - quartz veins intruded along shear zone

60 — Strike and dip of joints

Linear Structures (may be combined with planar structures)

30 — Bearing and plunge of mineral lineation

Small(?) anticline observed in outcrop, showing crestline and direction of plunge

Other Features

Trend of strong aeromagnetic lineament. Significance unknown

Bedrock Surface (Base of Potomac Formation)

50 — **Structure contour**. Line of equal elevation on the buried bedrock surface. The lines also represent the altitude of the base of the Potomac Formation. Contour interval: 50 feet. Datum is mean sea level

125 X — **Altitude of outcrop** where the base of the Potomac Formation was observed to rest unconformably on the bedrock surface. Color of symbol indicates the type of rock unit exposed

<45 X — **Altitude of outcrop** of the basal beds of Potomac Formation where the underlying bedrock is not exposed. Altitude of the bedrock surface is less than the altitude of the outcrop

<145 78 — **Altitude of the bedrock surface** as reported or inferred from geotechnical borings and water wells described by: Johnston, 1961 (○ ○); Darton, 1950 (▽ ▽); and Froelich, 1985 (△). Queried where doubtful. Underlined values represent a firm bedrock surface elevation penetrated and reported in boreholes. Numbers followed by "cs" (only associated with Johnston wells) represent the elevation of the bottom of the well casing for wells where no bedrock elevation is reported, but whose depth suggests that the casing may be seated in or near bedrock. Numbers preceded by a "less than" sign represent maximum possible bedrock elevations based on the bottom elevations of wells and boreholes that did not reach bedrock. The type of bedrock reported (if any) in a well is represented by a colored symbol corresponding to the bedrock colors shown on the map.

174 cs -400 ○ ○

<-440 ○

<-390 ▽ ▽ 95

<-375 △ △ 22

Crop line separating areas where Piedmont crystalline rocks and/or their residual soil are exposed at the surface (indicated by the darker map tones) from areas where bedrock is buried by younger Coastal Plain strata and other unconsolidated deposits (indicated by lighter map tones)

MAP SHOWING BEDROCK GEOLOGY, TOPOGRAPHY OF THE BEDROCK SURFACE, AND AREAS OF BEDROCK EXPOSURE IN THE CITY OF ALEXANDRIA, VIRGINIA AND VICINITY

By Anthony H. Fleming, 2015